US LARP Magnet Program

- Develop collaborative environment between national lab programs
- Improve long-term physics research opportunities of the LHC
  - Provide technology choices for AP
- Extend US expertise in high–field accelerator magnets
  - Represents the first opportunity to use Nb_3Sn in an accelerator
- Develop world-wide collaboration on high-performance magnets
  - CERN, ESGARD, KEK, EU, etc.
  - Workshop on Advanced Accelerator Magnets

LHC Accelerator Upgrades

- Luminosity (IR upgrade)
  - Options
    - **IR I**
      - **Large aperture quad with maximum gradient > 250 T/m**
    - **IR II**
      - **High gradient 2/1 quad with maximum gradient > 300 T/m**
      - **Large bore separation dipole with a field > 15 T**
      - **Smaller bore, 2/1 dipole with a field > 15 T**

Initial program target

- Energy Upgrade
  - Technology development supported by LARP, applied through LBNL base program
    - Small aperture, high field arc dipoles (17 T)

LARP Magnet Program

- Focus is on Nb_3Sn, large-aperture quadrupoles
- Also considers development of high-field beam-separation dipoles
  - Required in all IR upgrades scenarios under consideration
- Builds on "generic" Nb_3Sn dipole R&D programs
- Initial program is to develop technologies, not specific designs
- Specific design choices will be made after several years of magnet R&D and related accelerator design studies

Base Program Support

- Integrate the three US laboratories
  - Supported by
    - Existing technology base
    - Intellectual resources
    - Facilities

Existing base programs

Conductor Development Program

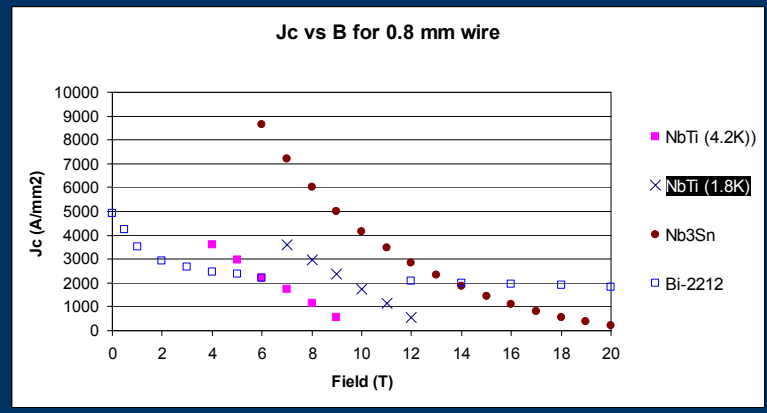
- essential to the success of LARP

- BNL – React and wind Nb_3Sn and HTS studies
- FNAL – Wind and react Nb_3Sn cos-theta dipoles
- LBNL – High field, Nb_3Sn dipoles
- Conductor Development Program

LARP Magnet Program

- Main Issues
  - High fields and gradients
  - Large beam-induced heat loads

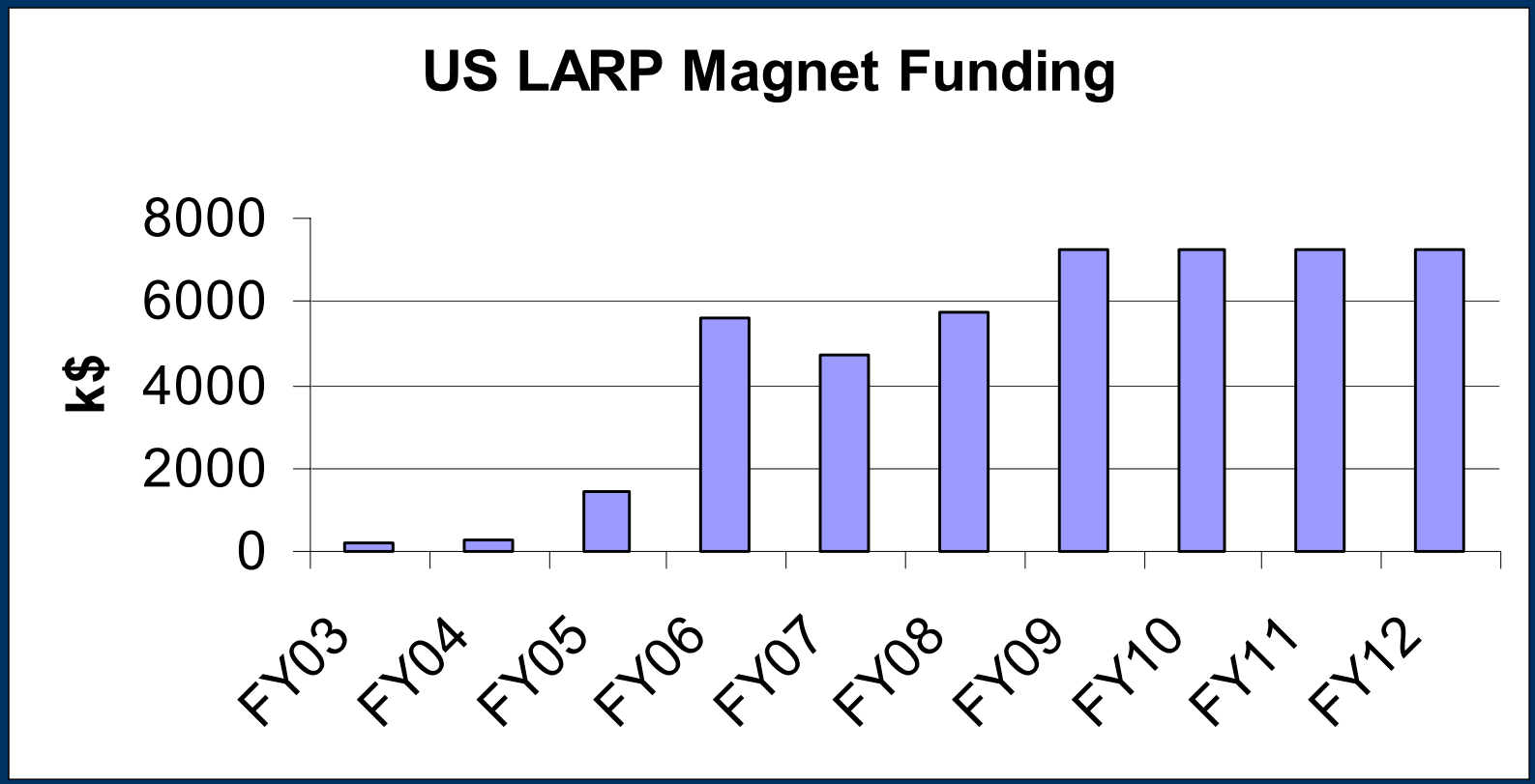
Nb_3Sn



- Extend and quantify limits on key performance parameters
- Issue-driven program designed to develop an enabling technology base for LHC upgrades and future accelerators

- 2003 – 05
  - Technology, simple models
- 2006 – 09
  - More complex models
- 2010 – 12
  - Accelerator-ready prototype

LARP Magnet Program

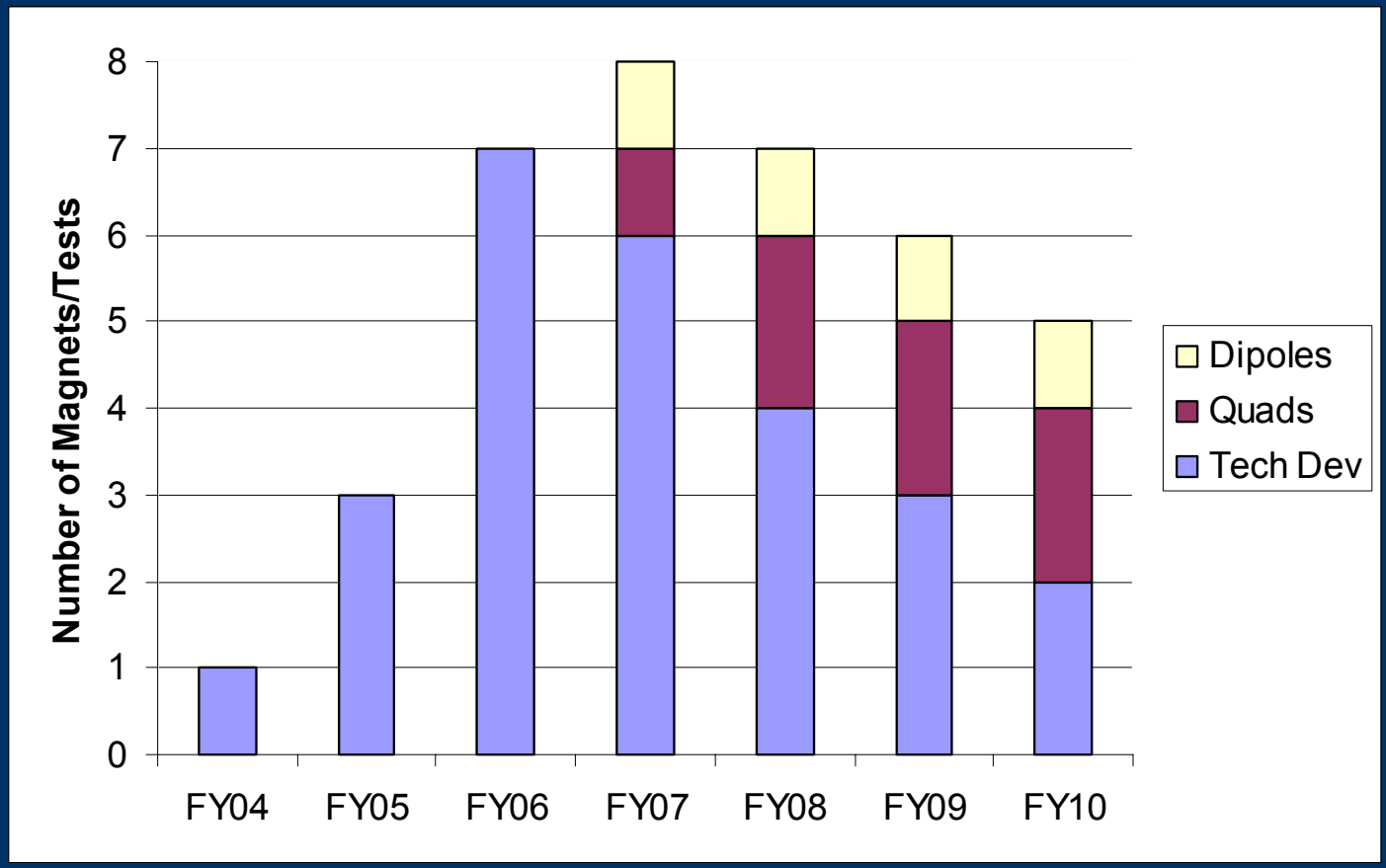


R&D Strategy

- Delayed funding turn-on
- Need to establish basis for future planning

- Highly leveraged, cost efficient start
- Focus on technology development

Program Profile



R&D Topics

- High fields/gradients
- Large aperture
- High, radiation induced heat loads
- Lifetime

Issues derived from requirements:

Mechanical support structures
Quench Protection
SC strand and cable
Heat transfer
Rad hard materials
Appropriate IR designs

- Program must address
  - Technology development and fabrication techniques
  - Field reproducibility
  - Length issues
  - Field quality reproducibility

LARP Technology Development Program

- Goals
  - Cost-effective way to investigate new techniques, materials and designs
  - Provide basis for program planning and development
- Initial Program
  - Conceptual designs
    - Identify primary issues
  - Technology Development
    - Range in complexity from simple mechanical models to full-scale short models and 4 m coil tests
    - Many important topics can be studied using a parametric approach

SC Materials and Cable Development

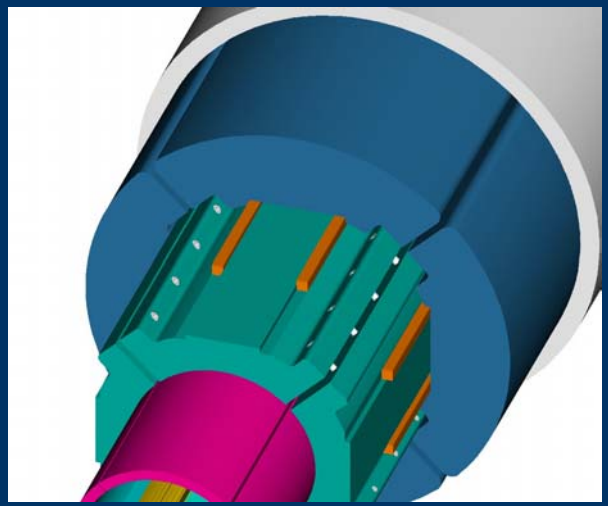
- Materials
  - Nb_3Sn
    - J_c
    - Magnetization (D_{eff})
  - HTS?
- Cable R&D
  - Explore the limits of Rutherford-type cables
    - New techniques
  - Fully keystoned Nb_3Sn
    - New Materials (HTS)
- DOE Conductor Development Program
  - Significant progress on Nb_3Sn J_C
    - 50% increase in 3 years
    - > 3,000 A/mm^2 at 12 T and 4.2 K

FY04 Magnet Program

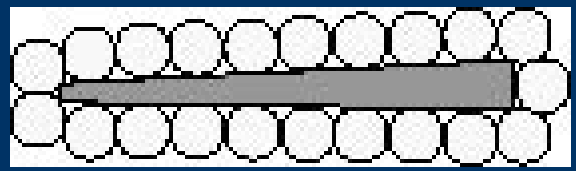
- Dipoles
  - Mechanical analysis of BNL design
  - Heat transfer
    - Modeling
    - Measurements via sub-scale model(s)
- Cable R&D
  - Keystoned cable (map parameter space, new techniques?)
  - Evaluation (extracted strand measurements)
- Quad Support Structure (labor + most M&S supported by base programs)

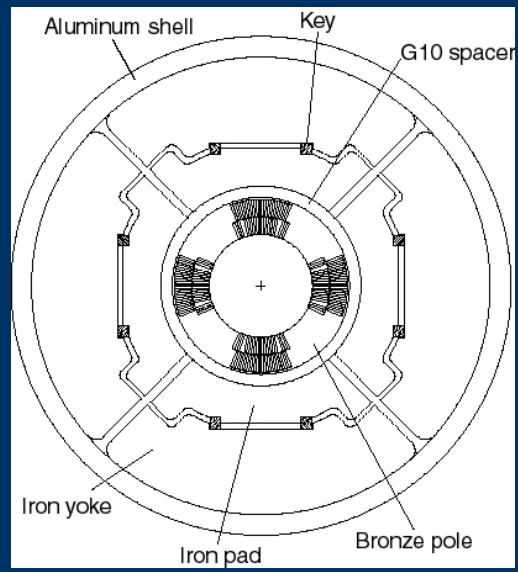
LARP Technology Development

- Rapid, cost-effective start using existing techniques and infrastructure
  - Support structure based on LBNL bladder and key assembly technique
  - Phase II – use D20 tooling for 2-layer coils



230 T/m
90 mm bore





FY04 Labor Breakdown

- Heat Transfer
  - Analysis — BNL 0.2 S/E
  - Studies — BNL 0.1 S/E, FNAL 0.1 S/E, LBNL 0.2 S/E, 0.2 D/T
- Dipole
  - Design — FNAL 0.2 S/E
  - Dipole mechanical structure — BNL 0.2 S/E
- Cable studies — FNAL 0.1 S/E, 0.1 D/T; LBNL 0.1 S/E, 0.1 D/T

Labor Summary

	S/E	D/T
BNL	0.5	0.0
FNAL	0.4	0.1
LBNL	0.3	0.3
Total	1.2	0.4

FY04 M&S Breakdown

• Heat transfer studies	LBNL $5k
• Cable studies	FNAL $2k, LBNL $5k
• Quad structure	LBNL $10k

LARP Magnet Workshop

September 16-18, 2003

Port Jefferson, NY

- Joint meeting with AP group
- Work on details of FY04 activities
- Plan FY05